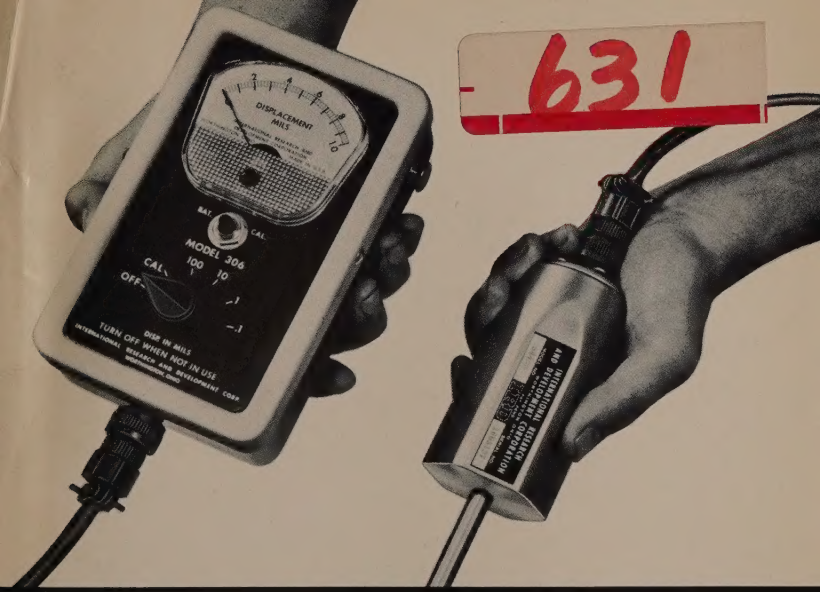
631



OPERATION AND MAINTENANCE

MANUAL

IRD

Self-Powered
Portable
Vibration
Meter

MODEL 306

International Research & Development Corporation is making available to industry electronic tools for practical and economical solutions of vibration and balancing problems. Our engineering and research departments are constantly developing new tools and instruments to solve other industrial problems through the science of electronics, though problems of true dynamic balance in industry are our first concern.

IRD # 446A

CONTENTS

Page No.

Warranty 4

Description 5, 6, 7, 8

Operation 9, 10, 11

Vibration Tolerance Charts 12, 13

Application 14, 15

Maintenance 17

Circuit Description 17, 18

Calibration 19, 20

Tube Layout 21

Parts List 22

Schematic Diagram 23

Serial Numbers 24

WARRANTY

IRD Corporation warrants that all of its products are free from defects in material and workmanship under normal use and authorized service for a period of one (1) year from the date of original purchase with the exception of electronic parts. Electronic parts, i.e., tubes, relays, etc., are warranted for 90 days minimum or carry original manufacturer's warranty. Such defects will be corrected providing the equipment is returned to IRD's factory at the purchaser's expense.

This warranty does not apply to equipment showing abuse or damage or to equipment which has been altered or repaired by others except as authorized by IRD. Nor does it extend to products which have been subjected to a corrosive and/or abnormal atmosphere.

In no event will responsibility be assumed or implied for consequential damages arising from interrupted operation or any other causes. Vibration levels and /or tolerances must be established by purchaser.

This warranty is in lieu of all other warranties express or implied and no one is authorized to assume any liability on behalf of IRD or to impose any obligation on it in connection with the sale of any equipment other than as outlined above.

IRD

MODEL 306

Portable Vibration Meter

INTRODUCTION

The IRD Model 306 Portable Vibration Meter is a rugged, accurate and reliable electronic instrument designed to detect and measure vibration. Self-powered and completely portable, this instrument derives its advantages from the use of sub-miniature tubes, mercury batteries, and printed circuits. Summarily, this instrument affords versatility, sensitivity, and simplicity of operation wherever vibration measurements are to be made.

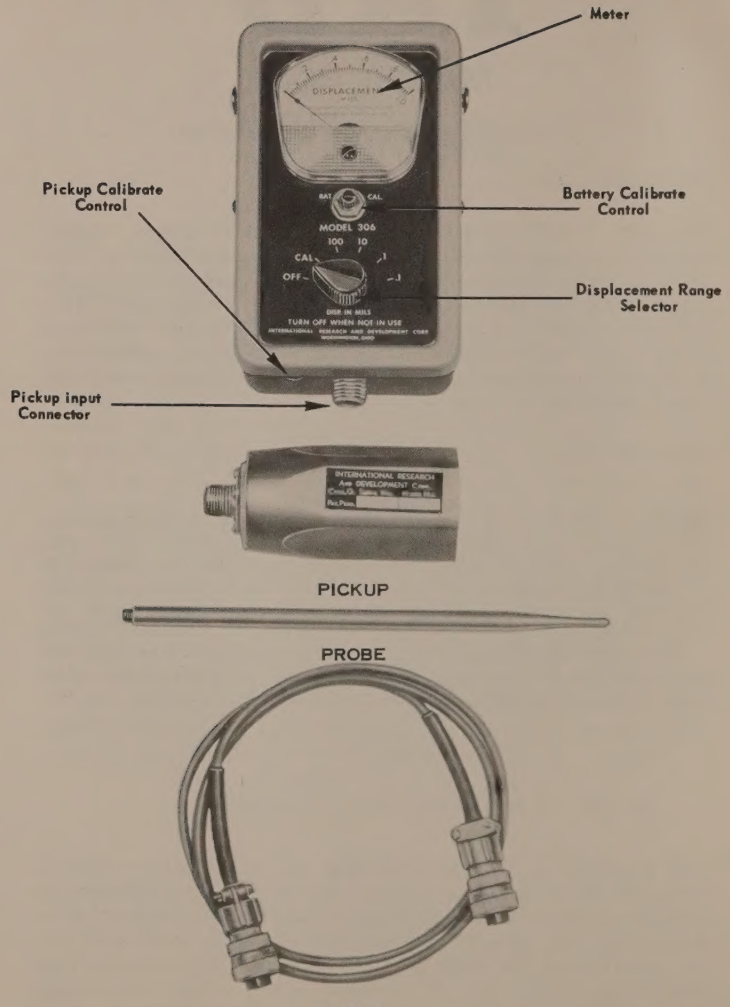
DESCRIPTION

The Model 306 Portable Vibration Meter consists of a rugged vibration pickup, an extremely stable amplifying system and a displacement meter. The vibration meter, the pickup, the extension probe, and the pickup cable are carried in a sturdy and attractive case. The meter is mounted in a metal enclosure which contains the printed circuits, sub-miniature tubes, and power supply batteries. The front panel contains a battery calibrate control, a displacement range switch, and the displacement meter. The input connector and the main pickup calibration control are located off the front panel at the bottom of the instrument. The physical dimensions of the case are:

Size: 6 1/2" x 4" x 2 1/2"

Weight: 30 ounces (including batteries)

The electrically damped vibration pickup (inductive-velocity type) IRD Model 544 is a rugged unit designed to withstand the rigors of industrial usage without impairment to calibration or sensitivity. The pickup responds only to vibrations in a direction parallel to the probe axis. Transverse response is less than 5% below 100 cps. A four-foot pickup cable is normally provided with the unit. Longer lengths are available.


Meter
Pickup Calibrate Control
Battery Calibrate Control
Displacement Range Selector
Pickup input Connector
DISPLACEMENT
BAT.
CAL.
MODEL 306
100
10
CAL
OFF
DISP. IN MILS
TURN OFF WHEN NOT IN USE
INTERNATIONAL RESEARCH AND DEVELOPMENT CORP.
PICKUP
PROBE
CABLE

The specifications of the vibration pickup are:

DIMENSION: 2-3/16" diameter by 4-27/32" length (including connector).

WEIGHT: 21 ounces.

TEMPERATURE RANGE: Minus 40° F. to 500° F. case temperature.

FREQUENCY RESPONSE: Room ambient (+77° F.) ±8% over the frequency range 12-1000 cps. Down 20% ±8% @ 10 cps. Pickup frequency response drops exponentially at lower frequencies. Elevated ambient (+250° F.) ±13% over the frequency range 12-1000 cps. The above limits are total variations for any mounting position of the pickup.

SENSITIVITY: 240 millivolts RMS ± 10% for .001" peak-to-peak displacement @ 100 cps corresponding to a velocity constant of 1.08 volts peak per inch per second. Sensitivity is unaffected by orientation.

The amplifier system is capable of indicating the peak-to-peak displacement with any velocity transducer (other than the pickup included with the system) which has a minimum velocity constant of 600 millivolts per inch per second peak, and a maximum output impedance of 8000 ohms (resistive), constant over the frequency range of 10 cps to 2000 cps (cycles per second).

The displacement meter is graduated from 0 to 1, each major graduation being divided into five sub-graduations to provide greater accuracy in reading. The DISPLACEMENT switch permits selection of an OFF position, a CAL position, and four DISPLACEMENT ranges. The four displacement ranges are:

.1 = 0 to 0.1 mil peak-to-peak displacement full scale;

1 = 0 to 1.0 mil peak-to-peak displacement full scale;

10 = 0 to 10.0 mils peak-to-peak displacement full scale;

100 = 0 to 100 mils peak-to-peak displacement full scale.

(One mil is equivalent to one thousandth of one inch).

A PICKUP CALIBRATION adjustment is provided for rapid calibration purposes. The PICKUP CALIBRATION is accessible through a small hole next to the INPUT connector at the bottom of the instrument. This control is a screwdriver control recessed to prevent the possibility of inadvertent adjustment.

Long-life batteries provide the power required to operate the vibration meter. Fig. 1 shows the location of each battery.

"A" - Two RM-12R "Mallory" or #E12 "Eveready" Mercury.
"B" - One #416 "Eveready" - 67 1/2 volt.

Emergency Replacement: "A" - #915 "Eveready" or equivalent.
"B" - Any make with NEDA #217.

The normal life of the batteries used in the Model 306 exceed 150 hours continuous operation.

CAUTION

Turn the DISPLACEMENT switch to the OFF position when the instrument is not in use.

-NOTE-

When carrying the Model 306 in its hardwood case the lid will not close unless the DISPLACEMENT switch is in the OFF position.

The specifications on the Model 306 amplifier system are:

DISPLACEMENT RANGE: 0 to 100 mils peak-to-peak displacement on four ranges of 0.1, 1.0, 10, and 100 mils full scale reading.

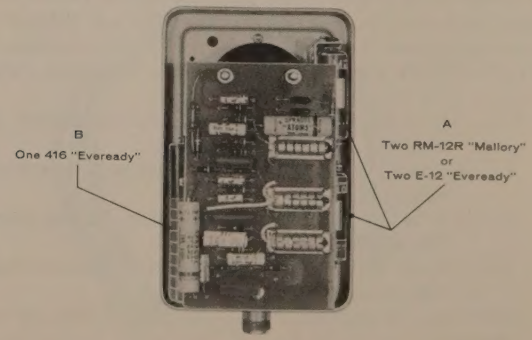


FIGURE I

ACCURACY: ±3% over the vibration frequency range of 12 cps to 1000 cps, with an operating ambient temperature of 60 degrees F. to 70 degrees F.

±10% over the vibration frequency range of 10 cps to 2000 cps, with an operating ambient temperature of 32 degrees F. to 120 degrees F.

INPUT IMPEDANCE: 100,000 ohms

MAXIMUM SENSITIVITY: .17 millivolts/cps for full scale indication on the most sensitive range.

OPERATION

IRD Model 306 is a portable vibration meter designed to detect and measure the peak-to-peak vibration displacement. (See Figure 2).

The principle of operation of this instrument is as follows:

The vibration pickup transforms the mechanical vibration being observed into a corresponding electrical signal whose voltage is directly proportional to the DISPLACEMENT of the vibration being measured. This signal is then registered on the displacement meter, thereby giving the displacement directly in mils.

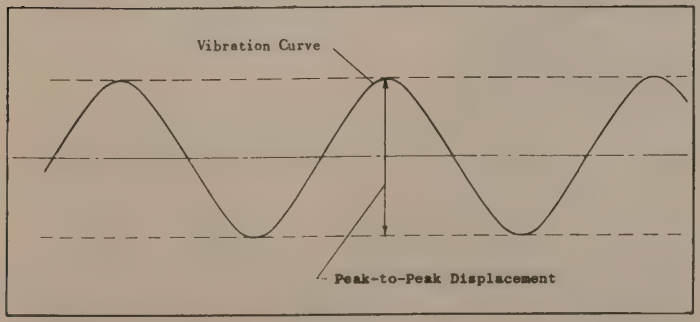
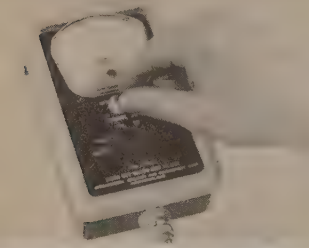


FIGURE 2

Operation of Model 306 Vibration Meter consists of these four easy steps:

STEP 1 Plug in one end of pickup cable to pickup and the other end to input connector on bottom of case and attach probe to pickup.



STEP 2 Turn the DISPLACEMENT range switch to the CAL. position. After five to ten seconds the displacement meter should read full scale. When the meter reads more or less than full scale adjust the BAT.-CAL control until a full scale reading is obtained. This indicates that the "B" voltage is normal and the Model 306 is ready for use.

STEP 3 Apply vibration pickup to the housing of the part whose vibration is to to measured. Hold probe firmly against machine to be checked.

STEP 4 Set DISPLACEMENT range selector to least sensitive position (100) and take reading. If meter reading is less than .1 full scale, change displacement selector to the next position (10) and repeat operation. If meter reading is still less than .1 full scale change selector to the next position (1.0) and obtain on-scale reading. If meter reading is still below .1 scale, use most sensitive displacement scale (.1 mil full scale).

MEASURING VIBRATION

Any machine having rotating or reciprocating components has a certain amount of vibration. When vibration becomes excessive it can cause trouble of four different types:

1) Damage to machines from fatigue and stress which results in high maintenance costs, down time losses and safety hazards.
2) Poor equipment performance showing up as a chatter, poor finish and inability to hold dimensional tolerance, etc.
3) Human fatigue and discomfort from vibration and associated noise.
4) Outward signs of poor quality both in industrial and commercial products.

A convenient remedy for the situations described above is the periodic measurement of vibration to assure that it is within the prescribed tolerance.

In checking machines having rotating parts, readings should normally be taken perpendicular to the axis of rotation. However, because the pickup is not affected by orientation, measurements may be made in any mounting position of the pickup - horizontally, vertically, or axially.

NOTE

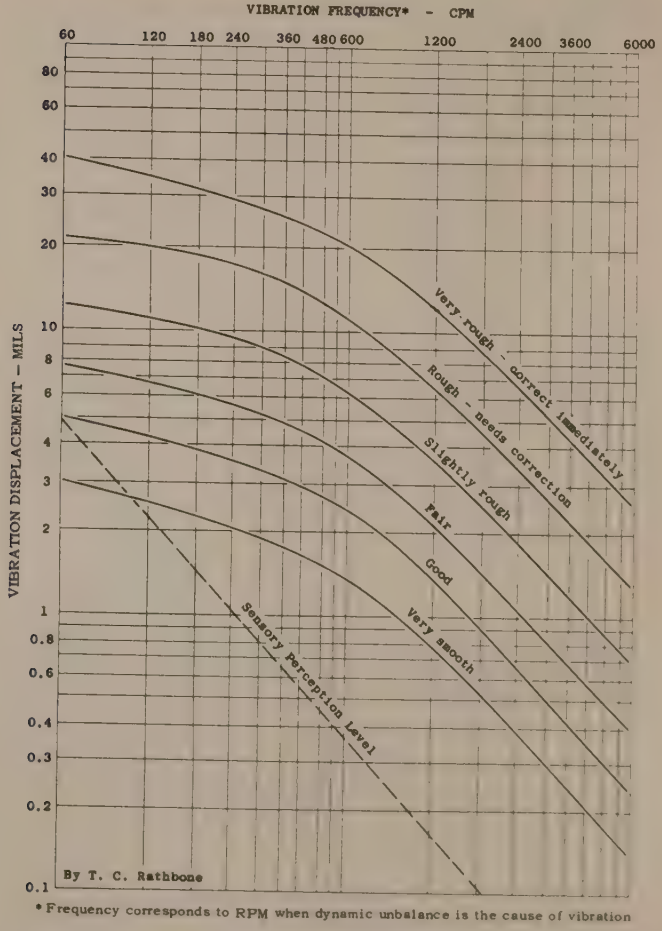
The vibration measured is that which occurs in a direction along the axis of the pickup.

In making repeated checks over a period of time, measurements should be made at the same point, in the same direction, and under the same operating conditions of the machine.

When checking lightweight parts on which hand pressure might affect the vibration of the part, always be careful not to apply any more pressure than is necessary to prevent chattering of the probe.

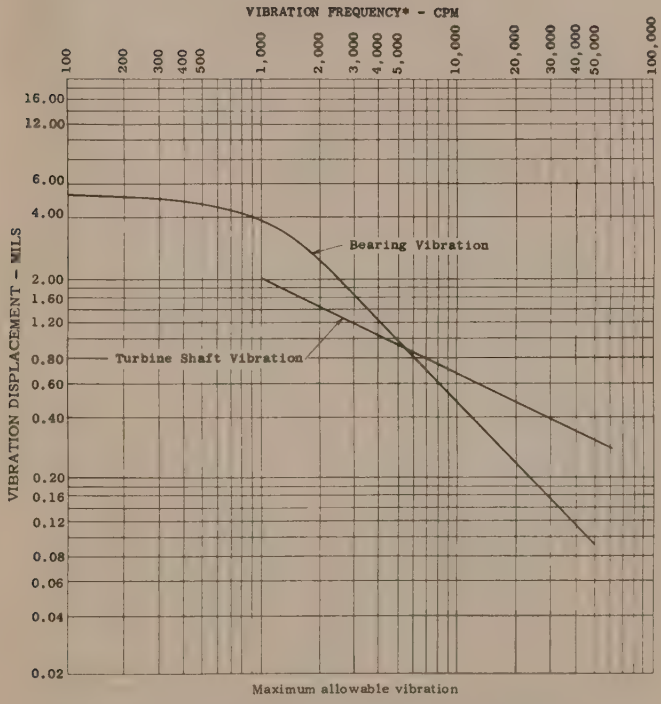
If there is more than one Model 306 in use, always use the same pickup with the same meter in order to benefit from the calibration set at the factory. (Record serial numbers in blanks provided on page 30 of this booklet). In case of emergency, a different pickup may be used but the difference in calibration should be taken into consideration.

Charts illustrating the approximate degree



The values of this chart (by T.C. Rathbone) are based on practical data obtained from a large number of machines and are only an approximate guide. Wide variations from these values may be expected from individual machines.

vibration which can be tolerated on machinery.



* Frequency corresponds to RPM when dynamic unbalance is the cause of vibration

The values on this chart are for shipboard equipment as noted in MIL-STD-167 (SHIPS) 12/20/54. The vibration levels are much too excessive to be applied to precision machine tools and equipment and should definitely not be used for such machinery.

APPLICATION

The IRD Model 306 Portable Vibration Meter is designed to detect and measure vibration displacements in various fields of application such as preventive maintenance, incoming inspection, quality control, sales, field service, etc. The instrument can be used easily in each field without any specific training on the equipment.

The standard application method consists of the following:

> Charts are drawn up (see Figure 3) showing the location of the rotating components of a machine, the vibration tolerances at each location, and allowing space to record the data obtained. A comparison with the established tolerances or with recorded reading indicates the status of the machinery. When a high level of vibration is indicated on a machine, an IRD Vibration Analyzer can be used to troubleshoot the machine and perform in-place dynamic balancing.

To illustrate the above described method, and the flexibility of this instrument, consider the case of a major machine tool manufacturer:

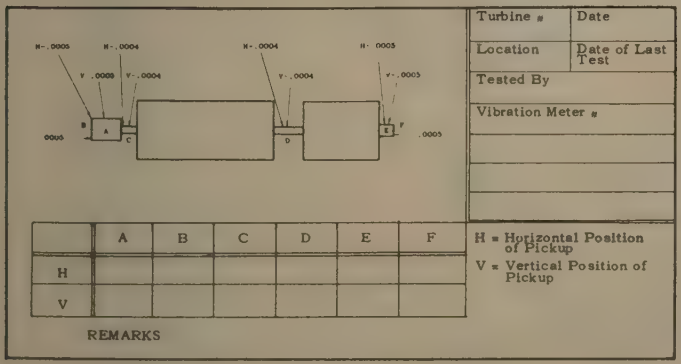
a) Maintenance men take periodical vibration readings with the Model 306 and compare the results with their standards. If vibrations are excessive, they are unable to plan the repair or replacement of the affected parts at an opportune time.

b) The receiving department checks each purchased component with this instrument and rejects those with high-level vibration before they are assembled in the finished product.

c) Periodic vibration checks of production machines permit the detection of any high level vibration which might alter the quality of the machined product. This method minimizes the amount of rejects which occur when a finished product has to reach final inspection before a malfunction may be detected.

d) Quality control inspectors carry this model anywhere on the production line to insure that the product is within vibration tolerance standards.

e) Outside the plant, field servicemen use this instrument to measure the vibration on machinery anywhere in the field because it does not require an outside power source and can be carried in a car, a tool chest, or even in a briefcase.



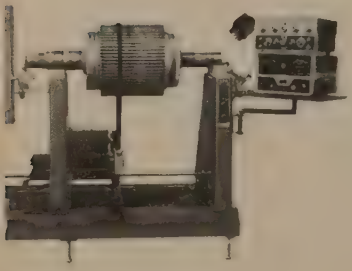
	A	B	C	D	E	F
H						
V						

FIGURE 3

IRD SYSTEMS at work in industry

CHECKING-Jig Boring machine is inspected with Model 306 to check for an acceptable or not acceptable vibration level --the key to its efficient operating condition.

TROUBLESHOOTING-Once the 306 establishes the presence of high vibration, a Vibration Analyzer and portable balancer such as Model 600 is used to pinpoint the cause and correct it--without costly dismantling of machinery.



IRD DYNAMIC BALANCING SYSTEM-When it is required to balance a disassembled component such as this rotor, the portable analyzer is a part of a complete dynamic balancing system. Here, IRD Vibration Analyzer is used in conjunction with Model 110 Dynamic Balancing System.

MAINTENANCE

IRD Model 306 Portable Vibration Meter normally requires no mechanical maintenance. There are no lubrication points. Battery replacement is the only normal maintenance required.

To replace batteries, remove back cover of case by removing two screws. Replace batteries, carefully matching the polarity as indicated on the base of battery holders.

Long-life batteries provide the power required to operate the vibration meter. Fig. 1 shows the location of each battery. Battery part numbers are:

"A" - Two RM-12R "Mallory" or #E12 "Eveready" Mercury.
"B" - One #416 "Eveready" - 67 1/2 volt.

Emergency Replacement: "A" - #915 "Eveready" or equiv.
"B" - Any make with NEDA #217.

In any event, replace batteries once per year. When any other malfunction occurs, return complete unit with pickup to the factory. The vibration pickup should always be returned to the factory to be repaired.

A circuit description, wiring diagram, parts list and tube layout appear in this manual which can serve as maintenance data for the users who have the necessary trained personnel and equipment to service this instrument.

CIRCUIT DESCRIPTION

The IRD Model 544 transducer used with Model 306 is terminated into an input load of approximately 100,000 ohms (R_1 thru R_5). The signal output at the switch arm of the range switch SW-1 is then applied to V_1 which is the linear electronic integrator. Integration is performed by the signal at the plate of V_1 being fed back to grid 4 of V_1 through condenser C_2. The amount of feedback voltage through C_2 is determined by the R_6-C_2 time constant.

The output of V_1 is then fed to the grid of V_2. V_2 is a voltage amplifier which, in turn, drives the grid of V_3. V_3 is the power tube driving the amplitude metering circuit. D_1 and D_2 rectify the wave from the plate of V_3. The rectified voltage is filtered by C_{10} and R_{16} producing an average DC component which drives meter M. Peak-to-peak reading on meter M is preset by R_5.

BAT.-CAL control - If the Model 306 is to read within the limits of its specified accuracy the voltages applied to the various tubes must be not less than certain values. These values are determined by the condition of the batteries that supply the necessary operating voltages. The battery whose voltage most affects instrument accuracy is the "B" battery, designated B_3 on the schematic diagram.

In order to compensate for the normal decrease in "B" battery voltage over the operating life of the battery, provisions have been made for adjusting the voltage applied to the tubes. When the DISPLACEMENT switch is rotated to the CAL position, a full scale meter reading of 1 should be obtained. This reading indicates that the "B" voltage is normal and the Model 306 is ready for use. If the meter reads more or less than full scale the BAT.-CAL control (located on front of instrument) is adjusted to obtain a full scale meter reading. When necessary to replace either the "A" or "B" batteries, see page 17 for battery replacement instructions. The batteries should be replaced as shown by Fig. 1, page 8. Batteries should always be replaced as a complete set. Observe correct polarity on "A" batteries.

It is recommended that spent batteries be removed from the case as they become exhausted to prevent corrosive damage to the Model 306.

NOTE

The BATT CAL position checks only the "B" battery.

PICKUP CALIBRATION - Two methods may be used to calibrate the Model 306 for use with a particular pickup.

The first of these methods involves the use of an audio signal generator which is adjusted to give a signal output equal to the pickup signal at a given frequency and load. This signal is then applied to the input of the Model 306 and the PICKUP CALIBRATE control adjusted to read the displacement, double-amplitude, corresponding to that pickup signal output. This method affords a rapid pickup- and instrument-check and in most applications, will be found useful.

Before calibration may be made, the pickup sensitivity must be known. This sensitivity must be in MVRMS/100CPS/.001 INCH

peak-to-peak. If the sensitivity is in MVRMS/INCH/SEC. conversion may be made to the required as follows:

$$e_o = \frac{K \pi f A}{1.41}$$

Where: e_o = MVRMS/100CPS/.001 INCH P-P

K = MVRMS/INCH.SEC.

f = 100 CPS

A = .001 INCH. P-P

π = 3.14

The signal output of the IRD Model 544 Vibration Pickup, which is the pickup normally supplied with the Model 306, is:

240 MVRMS/100CPS/.001 INCH
PEAK-TO-PEAK DISPLACEMENT

For identification and location of the PICKUP CALIBRATE adjustment, see the block diagram. The procedure for calibrating the Model 306 for use with a velocity-type pickup is as follows:

1) With the DISPLACEMENT SWITCH OFF, zero the displacement meter by means of the small adjusting screw located on the front face of the meter.
2) Switch the DISPLACEMENT SWITCH to CAL. and calibrate the "B" battery.
3) Turn the DISPLACEMENT RANGE switch to the 1-mil position.
4) Apply a signal to the Input connector (see the block diagram, Fig. 4)
5) Adjust the signal generator for 240 MV signal input at 100 CPS.
6) The displacement meter should now read full scale on the 1-mil range. If it does not, adjust the PICKUP CALIBRATE control until a full scale meter reading is obtained (1 mil).

The PICKUP CALIBRATE control of the Model 306 is now adjusted for proper operation.

The second method of pickup calibration is by use of an accurately calibrated shaker table system where the pickup is subjected to a known displacement and the PICKUP CALIBRATE control is adjusted to give the proper displacement meter reading. This method has the advantage of superior accuracy but is, at times, inconvenient if an accurate shaker system is not readily available.

Shown below is a block diagram of the test setup used when calibrating the Model 306 as previously outlined.

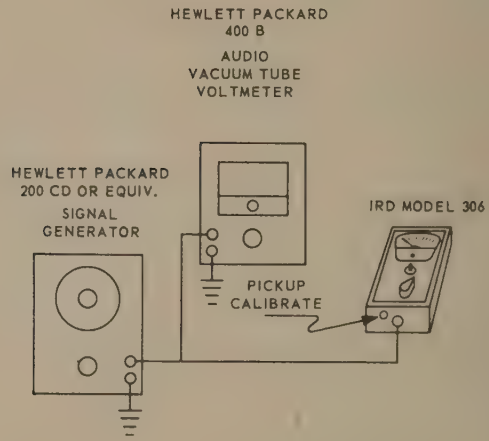
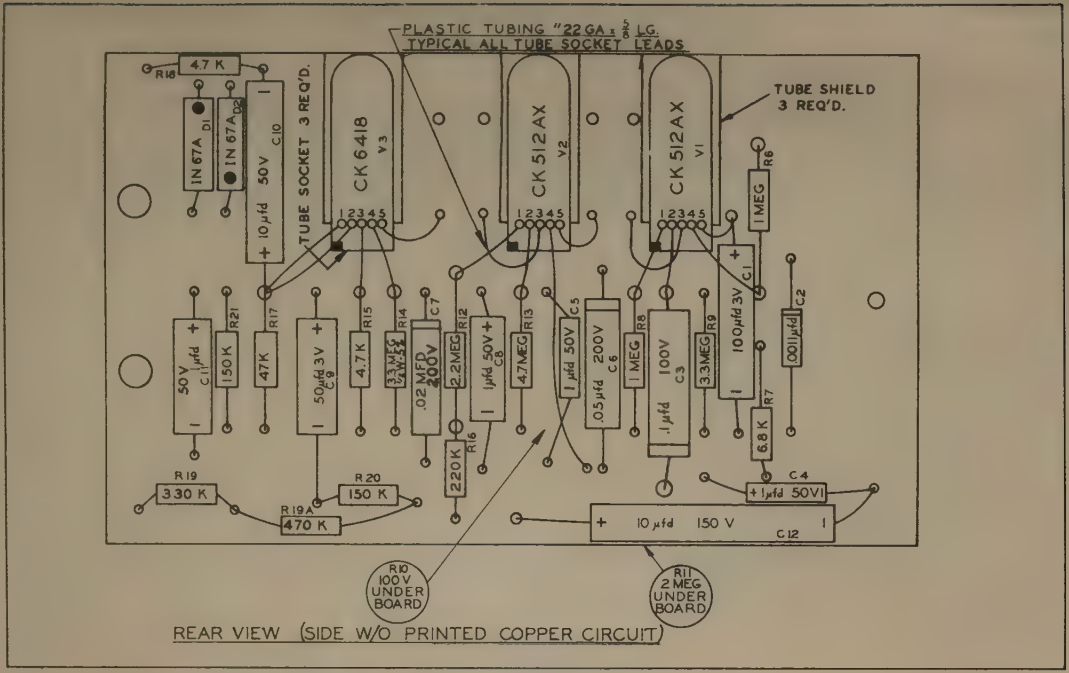


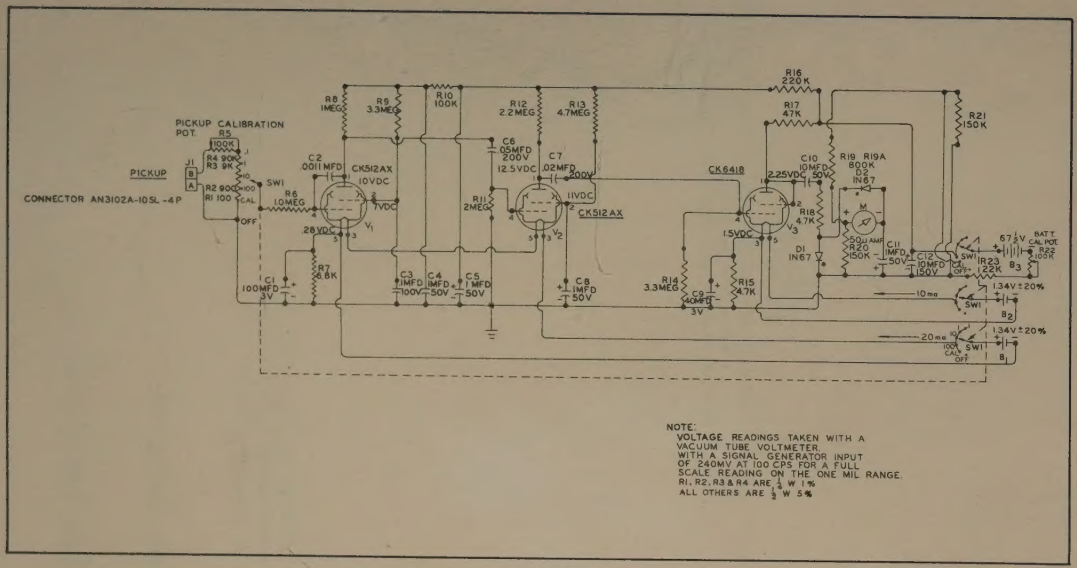
FIG. 4
BLOCK DIAGRAM
CALIBRATION SETUP



TUBE LAYOUT — Model 306 IRD Vibration Meter

• PARTS LIST

Circuit Symbol	Description	IRD Part No.
R1	100 ¼W, 1% Deposited Carbon	2877
R2	900 ¼W, 1% Deposited Carbon	2876
R3	9K ¼W, 1% Deposited Carbon	2875
R4	90K ¼W, 1% Deposited Carbon	2874
R5	100K Minature Potentiometer Linear Taper	2798
R6	1.0 Meg ½W, 5% Fixed Composition	1614
R7	6.8K ½W, 5% Fixed Composition	1594
R8	1.0 Meg ½W, 5% Fixed Composition	1614
R9	3.3 Meg ½W, 5% Fixed Composition	1620
R10	100K ½W, 5% Fixed Composition	1605
R11	2.0 Meg ½W, 5% Fixed Composition	1617
R12	2.2 Meg ½W, 5% Fixed Composition	1618
R13	4.7 Meg ½W, 5% Fixed Composition	1621
R14	3.3 Meg ½W, 5% Fixed Composition	1620
R15	4.7K ½W, 5% Fixed Composition	1593
R16	220K ½W, 5% Fixed Composition	1609
R17	47K ½W, 5% Fixed Composition	1601
R18	4.7K ½W, 5% Fixed Composition	1593
R19	330K ½W, 5% Fixed Composition	1610
R19A	470K ½W, 5% Fixed Composition	1611
R20	150K ½W, 5% Fixed Composition	1607
R21	150K ½W, 5% Fixed Composition	1607
R22	100K SU41 Potentiometer #4 Taper	2798
R23	22K 1W, 5% Fixed Composition	1641
C1	100 mfd 3V TE1059.5 Miniature Electrolytic	3668
C2	0.0011 mfd 500V 15% 5A5D11 "Super Micadon" Mica	2794
C3	0.1 mfd 100V 20% WMF Series	3345
C4	1.0 mfd 50V TE 1300 Miniature Electrolytic	1473
C5	1.0 mfd 50V TE 1300 Miniature Electrolytic	1473
C6	0.05 mfd 200V P8292ZN9	1462
C7	0.02 mfd 200V P8292ZN7	1463
C8	1.0 mfd 50V TE 1300 Miniature Electrolytic	1473
C9	50 mfd 3V TE 1058 Miniature Electrolytic	2913
C10	10 mfd 50V Series TVA 1304	2795
C11	1.0 mfd 50V TE 1300 Miniature Electrolytic	1473
C12	10 mfd 150V Series TVA 1406	2796
SW1	4-pole 6-pos #1 pos "Off" Type PA 117 Sub-Min Switch	2782
D1	1N67 Germanium Rectifier	1380
D2	1N67 Germanium Rectifier	1380
M	50 Microamp Meter Model 1721	2781
B1	1.34 VDC Mercury "A" Battery #RM-12R	1028
B2	1.34 VDC Mercury "A" Battery #RM-12R	1028
B3	67½ VDC "B" Battery, #416 Eveready or NEDA #217	2797
J1	AN3102A-10SL-4P Pickup Connector with countersunk mounting holes	280
V1	CK512AX Sub Miniature Tube	1403
V2	CK512AX Sub Miniature Tube	1403
V3	CK6418 Sub Miniature Tube	1414



NOTE:
VOLTAGE READINGS TAKEN WITH A VACUUM TUBE VOLTMETER.
WITH A SIGNAL GENERATOR INPUT OF 240MV AT 100 CPS FOR A FULL SCALE READING ON THE ONE MIL RANGE.
R1, R2, R3 & R4 ARE $\frac{1}{2}$ W 1%
ALL OTHERS ARE $\frac{1}{2}$ W 5%

SCHEMATIC — IRD Model 306 Vibration Meter

IRD

INTERNATIONAL RESEARCH AND DEVELOPMENT CORPORATION

Subsidiary of H. H. Robertson Co.

6150 Huntley Road, Worthington, Ohio (Columbus), Phone 885-5376

When ordering parts or requesting information always refer to meter and pickup serial numbers.

Meter Serial No. _____

Pickup Serial No. _____

IRD

INTERNATIONAL RESEARCH
AND DEVELOPMENT CORP.

•

WORTHINGTON, OHIO